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H3W WVX

(56) Documents Cited:

FR 001585106 A	**US 5280168 A**
US 5053994 A	**US 5047621 A**
US 4904067 A	**US 4412235 A**
US 3728593 A	**US 3043958 A**

(58) Field of Search:
INT CL^7 **H01L, H03F, H03K**
Other:

(54) Abstract Title: **A binary or analogue opto-isolator using an undoped GaAs photoconductor**

(57) The use of a high-resistivity Gallium Arsenide bulk photoconductor as the photo-receiver in an opto-coupler allows control of very low currents at high output voltages. An array of bulk GaAs photo-receivers may be controlled by projecting an image from a CRT or LCD display onto the array or by scanning a laser across the array. A filter 6 may be interposed between the light source and the photoreceiver to convert wavelength modulation to intensity modulation. Phosphorescent or fluorescent elements 9 may be inserted (figure 2) to provide persistence, especially in a scanned arrangement. The arrangement may be used to drive many high-impedance elements including piezoelectric, electrostatic, electroactive, electrostrictive, electroadhesive, electroprecipitive, electro-optic, electrophoretic and electrorheological devices.

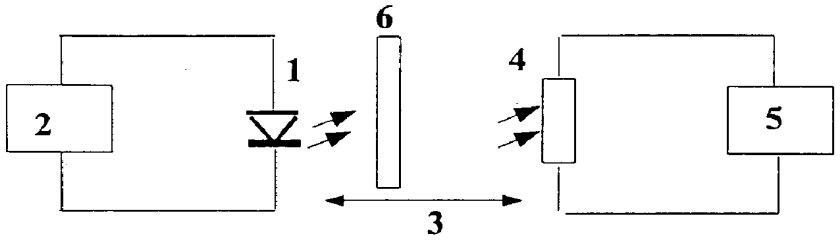

Figure 1 - basic high voltage opto-isolator element.

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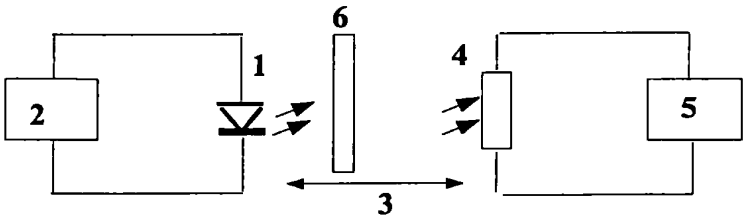
Drawings



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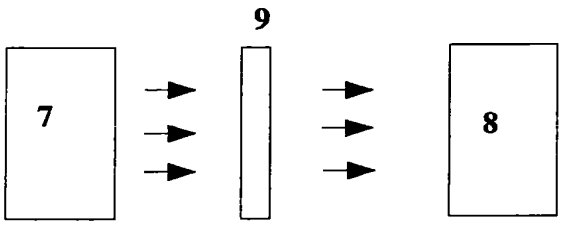

Figure 2 - high voltage opto-isolator array driven from 2D luminous source.

Opto-isolated high voltage control array.

Description

Electrical isolation between different equipments is usually achieved by means of discrete opto-couplers. These invariably comprise an electrical to optical transducer (lamp or LED) and an optical to electrical transducer (Photodiode or phototransistor). The physical distance of the optical path provides an electrical isolation proportional to the said distance. However, the electrical outputs of such devices are themselves unable to control voltages higher than those sustainable by the optical to electrical transducer (typically between 30 and 300 volts).

The electrical control of two dimensional arrays of devices is normally carried out either by direct wiring (difficult and expensive with large arrays) or by multiplexing (restricted to the switching of bistable devices or devices having turn-off time constants longer than the multiplex refresh rate).

This invention describes a system capable of controlling several thousand volts as well as providing several thousand volts of galvanic isolation whilst also being applicable to the control of several channels (analogue and digital) simultaneously without the need for multiplexing.

The electrical to optical transducer may, as in conventional low voltage systems, simply comprise a lamp, LED or laser. However, the optical to electrical transducer must exhibit certain characteristics:

1. The output electrical resistance of the optical to electrical transducer should change only in accordance to changes in the luminous characteristics of the light emitted from the electrical to optical transducer.

2. The output electrical resistance of the optical to electrical transducer should not be dependant on the high voltage intended to be controlled by the said output electrical resistance.

3. The output electrical resistance of the optical to electrical transducer may vary linearly or non-linearly in accordance with changes in the luminous characteristics of the light emitted from the electrical to optical transducer.

4. The output electrical resistance characteristics of the optical to electrical transducer must be identical in both directions of output current flow.

5. The control of very low currents (to less than 1 micro Ampere) by the output of the optical to electrical transducer must be possible.

Criterion 1 includes control by changes in intensity, wavelength or pulse characteristics of the light emitted from the electrical to optical transducer. Criterion 4 demands the use of a purely resistive device (i.e. not semiconductor elements with PN junctions). This suggests the use of light dependant resistors (LDR). However, conventional LDRs (employing materials such as Cadmium Sulphide/Selenium) are highly voltage dependant which contradicts criterion 2. Opto-isolated SCRs and triacs capable of handling high voltages already exist. Unfortunately the hold on currents required exceed those dictated by criterion 5.

Undoped bulk semiconductor materials (such as Gallium Arsenide) which have no PN junctions are capable of fullfilling all criteria 1, 2, 3, 4 and 5.

Individual elements of the invention consist of two basic components as shown in figure 1. An electrical to optical transducer **1** driven from a low voltage signal source **2** emits light over a distance **3** to the optical to electrical transducer **4** which in turn controls a high voltage load **5** by means of changes in output electrical resistance of the optical to electrical transducer **4** as determined by changes in the optical characteristics of the emitted light by the electrical to optical transducer **1**.

The optical characteristics of the light emitted by the electrical to optical transducer **1** may sinply be intensity as determined by the input voltage **2.** The insertion of a filter **6** in the light path **3** may be used to convert changes in the emitted light wavelength from the electrical to optical transducter **1** into perceived optical intensity changes by the optical to electrical transducer **4** resulting in correspoding changes in the output electrical resistance of the electrical to optical transducer **4**. Alternatively, the filter **6** may be replaced or combined with a window comprising a phosphorescent or flourescent material used to prolong the hold-on time of the optical to electrical transducer **4** if desired.

When a plurality of such elements as depicted in figure 1 are combined to form a single of two dimensional array, a means is achieved whereby several high voltage channels may be controlled simultaneously. As shown in figure 2, an image, from a beamer, CRT, LCD, laser (or similar) display **7** may be projected directly onto the array **8**. Additional filter/window elements **9**, similar to those previously described **6**, may be included if/where desired. This allows high voltage optical isolation and high voltage control of up to several thousand channels without the need for expensive plug-in cards and computer interfaces. Furthermore, where simple optical image transfer is required the need for additional driver software and electrical hardware is obviated.

Similarly, the high voltage opto-isolator array may be illuminated (scanned) by means of a laser (or other light source) and a rotating polygonal and/or galvanometer mirror combination. In such cases the phosphorescent or flourescent members **9** shown in figure 2 may be necessary to prolong the decay time during the scan period.

The light sensitive elements **4** of the optical to electrical transducer array **8** are essentially of non doped bulk semicoductor (such as GaAs) form which may be separated from wafers of the same. No PN-junctions are required and all electrical connections are purely ohmic in nature.

Applications include the control and/or switching of high voltages for driving most forms of piezo-electric, electrostatic, electroactive, electrostrictive, electroadhesive, electroprecipitive, electrooptic, electrophoretic and electrorheological devices including pluralities and combinations thereof.

Claims

1. An opto-isolator element capable of controlling high voltages (several thousand volts) with an extremely small lower current limit (under 1 μA).

2. A device as claimed in claim 1 where the control may be analogue or digital in nature.

3. A device as claimed in claims 1 and 2 where the electrical resistance of the optical to electrical transducer is not, or only minimally, dependant on the voltage to be controlled.

4. A device as claimed in claims 1, 2 and 3 where the electrical resistance of the optical to electrical transducer may be controlled by the emitted luminous intensity of the electrical to optical transducer.

5. A device as claimed in claims 1, 2 and 3 where the electrical resistance of the optical to electrical transducer may be effectively controlled by the emitted luminous wavelength of the electrical to optical transducer.

6. A device as claimed in claim 3, 4 and 5 where the hold on time of the optical to electrical transducer may be extended by the addition of phosphorescent or luminescent window between the electrical to optical transducer and optical to electrical transducer.

7. A plurality of devices as claimed in claims 1, 2, 3, 4, 5 and 6 where several analogue and/or digital channels may be controlled simultaneously.

8. An array system as claimed in claim 7 whereby illumination is provided by a beamer, CRT, LCD, TFT (or other) image display unit.

9. An array system as claimed in claim 7 whereby illumination is provided by a laser scanner (direct, reflected or refracted).

Application No: GB0304769.3 **Examiner:** Mr K Sylvan

Claims searched: 1-9 **Date of search:** 3 August 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular reference
X	1-5	FR1585106 A RTC. See figure 5 and page 7 lines 11-26.
X	1,3 and 4	US5280168 A Kim. See column 2 lines 46-48.
X	1,3 and 4	US5047621 A Weiner. See column 1 lines 15-39 and column 2 lines 30-43.
A	-	US3043958 A Diemer. See column 3 lines 35-65.
A	-	US3728593 A Motorola. See column 1 lines 55-65 and column 2 lines 46-50.
A	-	US4412235 A Bois. See abstract, figure 4, and column 4 lines 1-11.
A	-	US4904067 A Siemens. See the abstract.
A	-	US5053994 A Radiant. See column 2 lines 62-67.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W] :

Worldwide search of patent documents classified in the following areas of the IPC[07]

H01L; H03F; H03K

The following online and other databases have been used in the preparation of this search report